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Effects of sedentary behavior in Metabolic Syndrome and its components in adults: A Systematic Review

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Abstract *— **Introduction**: the current society has been involved in activities that require less energy expenditure, this type of activity that requires energy expenditure <1.5 METs, excluding sleep, is called sedentary behavior and is independently associated with physical activity to deleterious health factors , as metabolic syndrome. **Objective**: to investigate, through a systematic review, the effects of sedentary behavior on the metabolic syndrome and its components in adults. **Methodology**: This is a systematic review, using the Trip Database databases through the following descriptors: adults; sedentary behavior or screen time or sedentary life style; cardiometabolic risk or cardiovascular risk or metabolic risk score, published between 2013 and 2018. **Results**: Some cross-sectional studies show a greater chance of developing metabolic syndrome when sedentary time is increased. However, most sedentary time intervention studies with mild physical activity or posture change do not have a significant effect on cardiometabolic markers. **Conclusion**: According to the results of the selected studies, there is an association between high sedentary time and the development* of metabolic syndrome and its components in adults

Keywords *— **Adult, Sedentary Behavior, Metabolic Syndrome.***

I. INTRODUCTION

The current model of society and technological advances can negatively affect the population's way of life, causing the human being to have to work less physically to perform his or her daily life tasks. For this reason, sitting time (watching television, motorized, using the computer, playing video games, hanging around chatting with friends, talking on the phone among other similar activities) who require little energy expenditure, has become increasingly prevalent society current (CHURCH et al., 2011). In this context, the definition of sedentary behavior was defined as a series of states in which the individual remains awake with energy expenditure <1.5 METs (Metabolic Equivalent Term), excluding sleep time (TREMBLAY et al., 2017).

Farias Júnior (2011) describes in his study that the term sedentary behavior is different from the sedentary one within the level of physical activity, since it has specific "categorical" as well as pathological consequences in the health of the individuals. Sedentary behavior is not characterized simply as an absence of physical activities or the attendance of specific scores in its classification (BIDDLE et al., 2009).

Sedentary behavior has been associated with several deleterious health factors such as obesity, type 2 diabetes, cardiovascular diseases and all-cause mortality (YOUNG et al., 2016). Among these factors, the metabolic syndrome has also received differentiated attention, since it is considered as a group of factors, which allies increase the chance of developing type 2 diabetes and cardiovascular disease (HUANG, 2009).

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Metabolic syndrome is classified in several ways, but the definition of the National Cholesterol Education Program (NCEP) is one of the most widely used criteria for the definition of metabolic syndrome, since it encompasses its main characteristics: hyperglycemia / insulin resistance, visceral obesity, atherogenic dyslipidemia and hypertension in addition to using measurements and laboratory results readily available to physicians, facilitating their clinical and epidemiological application (PENALVA, 2008).

The definition of the NCEP ATP III states that the individual is diagnosed with the metabolic syndrome when he has at least three of the following five criteria: waist circumference ≥102 cm for men and ≥88 cm for woman, blood pressure above 130/85 mmHg, fasting triglycerides (TG) above 150 mg / dL, fasting high density lipoprotein (HDL) levels below 40 mg / dl (men) or 50 mg / dl (women), and fasting blood glucose above 100 mg / dl (GRUNDY et al, 2005).

Some research, such as Young et al. (2016), demonstrate an increased chance of developing metabolic syndrome associated with increased sedentary time. However, these data are not conclusive, mainly in quantitative terms to affirm how much and how to reduce the sedentary time, for health benefits, especially the reduction of the risk of developing metabolic syndrome. In this context the objective of this systematic review is to investigate the effects of sedentary behavior on the metabolic syndrome and its components in adults.

II. METHODOLOGY

It is a systematic review of the literature, which is a way of synthesizing the information available at a given moment, on a specific problem, in an objective and reproducible way, by means of a scientific method (BANNINGAN; DROOGAN, ENTWISTLE, 1997). The stages of the research were divided into: theme definition, issue study problem, search strategy, inclusion and exclusion criteria, evaluation of included studies and synthesis of data collected.

Defining the problem of the study question

The question for the study was formulated from the PICO strategy, which according to Santos and Nobre (2007) means an acronym for Patient (population), Intervention, Comparison and Outcomes.

Table 1. Formulation of the PICO research strategy.

1. PATIENT/PROBLEM	2. INTERVENTION	3. COMPARISION	4. OUTCOME
Adults	Sedentary Behavior	-	Metabolic syndrome
QUESTION: What is the influence of sedentary behavior on the metabolic syndrome and its components in adults?			

Search strategy

The search for studies was carried out in the database "TRIP Database" through the PICO strategy, in which the descriptors used were: P: adults; I: sedentary behavior or screen time or sedentary life style; C: has not been applied; O: cardiometabolic risk or cardiovascular risk or metabolic risk score or metabolic syndrome.

The choice of the TRIP Database search tool was based on the fact that it is a free clinical search engine whose primary function is to help physicians and healthcare professionals identify the best scientific evidence available to answer clinical questions. Its roots are firmly in the world of health research, based on scientific evidence.

Inclusion and exclusion criteria

Included in this review were primary cross-sectional, longitudinal, cohort, and intervention studies that were published in English between 2013 and 2018 and evaluated the influence of sedentary behavior, measured by questionnaire or objectively, on the metabolic syndrome and its components in adults.

We excluded from this review articles that do not fit the inclusion criteria, studies that evaluate the population with locomotor and functional limitations and / or individuals with neurodegenerative diseases in general.

III. RESULTS

The search strategy allowed to find 19258 articles, after the application of the inclusion and exclusion criteria, the researches were allocated as shown in Figure 1 (*Prisma Flow*).

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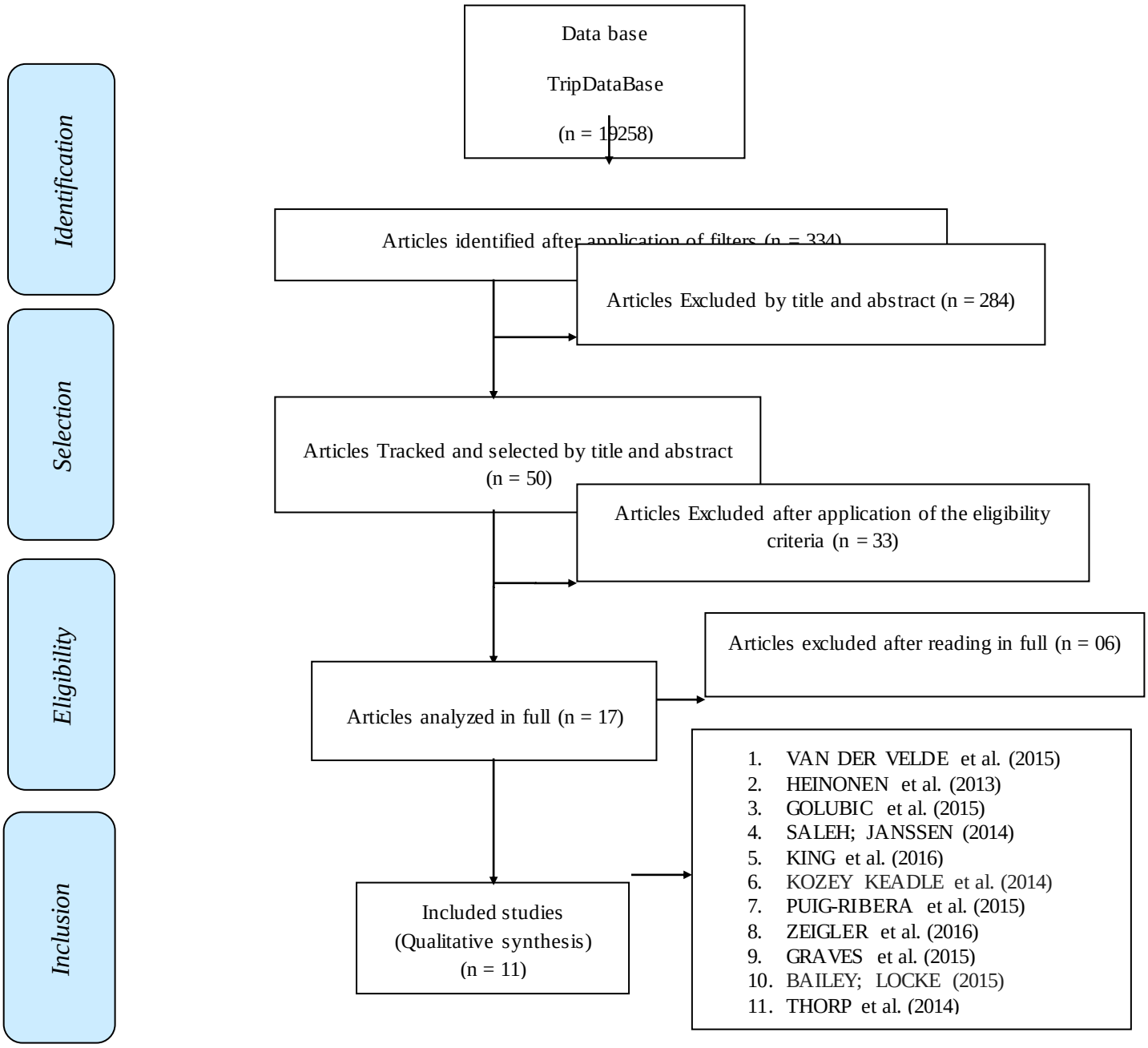
Fig. 1 - Flowchart of the studies selection (Prisma Flow)



Fonte: Autor, 2018 adaptação de Moher et al. (2008).

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Table 2. Synthesis of the productions included in the review about the influence of sedentary behavior on the metabolic syndrome and its components in adults, according to author and year, type of study and sample.

Title of study Author and Year	Type of study	Sample	Results
Moderate activity and fitness, not sedentary time, are independently associated with cardio-metabolic risk in U.S. adults aged 18-49 VAN DER VELDE et al. (2015)	Transversal study	The sample consisted of 543 participants aged 18 to 49 years	Results show that sedentary time was associated with HDL-cholesterol (β = −0.080, p = 0.05) and TG (β = 0.080, p = 0.03). These results became non-significant after adjustment for MVPA and fitness. MVPA was associated with WC (β = −0.226), BMI (β = −0.239), TG (β = −0.108) and HDL-cholesterol (β = 0.144) (all p < 0.05). These results remained significant after adjustment for sedentary time and fitness. Fitness was associated with WC (β = −0.287), BMI (β = −0.266), systolic blood pressure (β = −0.159), TG (β = −0.092), and CRP (β = −0.130) (all p < 0.05). After adjustment for sedentary time and MVPA these results remained significant.
Sedentary behaviours and obesity in adults: the Cardiovascular Risk in Young Finns Study HEINONEN et al. (2013)	Transversal study	Sample was composed of 1993 participants (1084 women and 909 men) between 30 and 45 years	Of the different sedentary behaviour types, TV viewing was most consistently related to higher BMI and WC, both in men and women. One additional daily TV hour was associated with a 1.81±0.44 cm larger WC in women and 2 cm±0.44 cm in men (both p<0.0001). The association with TV was diluted, but remained highly significant after adjustments with all measured covariates, including several potentially obesogenic food items associated with TV viewing. The intakes of food items such as sausage, beer and soft drinks were directly associated with TV viewing, while the intakes of oat and barley, fish, and fruits and berries were associated indirectly. After these adjustments, non-TV sedentary behaviour remained associated with adiposity indices only in women.
Physical activity, sedentary time and gain in overall and central body fat: 7-year follow-up of the ProActive trial cohort. GOLUBIC et al. (2015)	Randomized controlled trial of cohort	The sample consisted of n = 231 at the baseline, n = 222 at 1 year and = 230 at 7 years	MVPA was inversely and independently associated with all indices of total BF (for example, 1 s.d. higher MVPA was associated with a reduction in FM, β = − 0.09 (95% CI: − 0.14, − 0.04) s.d.) and abdominal BF (for example, WC: β = − 0.07 (−0.12, − 0.02)). Similarly, higher fat indices were independently

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			associated with a reduction in MVPA (for example, WC: β = − 0.25 (−0.36, − 0.15); FM: β = − 0.27 (−0.36, − 0.18)). SED-time was positively and independently associated with most fat indices (for example, WC: β = 0.03 (−0.04, 0.09); FM: β = 0.10 (0.03, 0.17)). Higher values of all fat indices independently predicted longer SED-time (for example, WC: β = 0.10 (0.02, 0.18), FM: β = 0.15 (0.07, 0.22))
Interrelationships among sedentary time, sleep duration, and the metabolic syndrome in adults SALEH; JANSSEN, (2014)	Transversal study	The sample consisted of 1371 participants	Sedentary time and screen time did not vary across sleep duration quartiles. Participants in the highest quartile of sedentary time were more likely to have the MetS than participants in the lowest quartile (odds ratio = 1.60, 95% CI:1.05-2.45). The odds of the MetS was higher in participants in the highest screen time tertile as compared to the lowest tertile (odds ratio = 1.67, 95% confidence interval:1.13-2.48). Sleep duration was not independently related to the MetS. There were no significant sedentary time X sleep duration interactions on the MetS.
Objectively-measured sedentary time and cardiometabolic health in adults with severe obesity. KING et al. (2016)	Transversal study	The sample consisted of 927 women with severe obesity and mean age of 45 years	That ST, independent of MVPA, is associated with several markers of cardiometabolic health, among adults with severe obesity prior to bariatric surgery.
The independent and combined effects of exercise training and reducing sedentary behavior on cardiometabolic risk factors KOZEY KEADLE et al. (2014)	Intervention study	The sample consisted of 57 overweight / obese (19M / 39F) participants (mean ± SD, age 43.6 ± 9.9 years, BMI 35.1 ± 4.6 kg / m 2), not exercised (<3 days / week for <20 minutes per session) and worked in inactive occupation (self-reporting> 75% day at work was sedentary expenditure)	The within-group analysis provides preliminary evidence that exercising and reducing ST may result in improvements in metabolic biomarkers that are not seen with exercise alone, though between-group differences did not reach statistical significance.
Patterns of impact resulting from a 'sit less, move more' web-based program in sedentary office employees PUIG-RIBERA et al. (2015)	Estudo de intervenção	The sample consisted of 264 workers (42 years of age, n = 171 women, n = 129 administrative staff).	No significant interactions between the moments of the group and the program for BMI, SBP and BDP were identified. The Intervention group significantly reduced waist circumference by 2.1 cm from baseline to follow-up, while the comparison group reduced waist

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			circumference by 1 cm. The reductions in waist circumference were not influenced when it was taken into account only by the self-reported cut in occupational session, were more influenced by the number of daily steps (≥1,000).
Effects of Standing and Light-Intensity Activity on Ambulatory Blood Pressure ZEIGLER et al. (2016)	Randomized cross-factorial study	The sample consisted of 09 overweight or obese adults (body mass index, 28.7 ± 2.7 kg, m (-2) adults (30 ± 15 years))	SBP during Standing (132 ± 17 mmHg), WALK (133 ± 17 mmHg) and CYCLE (130 ± 16 mmHg) were lower in comparison with SIT (137 ± 17 mmHg) (all P <0.01). CYCLE was smaller than STANDING (P = 0.04) and WALKING (P <0.01). For DBP, only CYCLE (69 ± 12 mmHg) was lower than SIT (71 ± 13 mmHg; P <0.01). Compared with SIT, WALK, STANDING and CYCLE, reduced SBP load by 4%, 4% and 13%, respectively (all P <0.01)
Evaluation of sit-stand workstations in an office setting: a randomised controlled trial GRAVES et al. (2015)	Randomized controlled trial	The sample consisted of 47 participants, with a mean age of 38.6, were randomized (intervention n = 26, control n = 21)	The effects of the intervention on fasting glucose or triglyceride plasma concentrations were not clarified. No statistically significant differences were observed for blood pressure.
Breaking up prolonged sitting with light-intensity walking improves postprandial glycemia, but breaking up sitting with standing does not BAILEY; LOCKE, (2015)	Randomized cross-over study of three periods and three treatments	The sample consisted of 10 non-obese adults participating in three trials (07 men, 03 women, mean age, 24.0 ± 3.0)	The area of systolic and diastolic blood pressure under the curve did not differ significantly between the conditions nor the responses in the lipid parameters (p> 0.05).
Alternating bouts of sitting and standing attenuate postprandial glucose responses. (THORP et al, 2014)	Randomized case-control study	The sample consisted of 23 sedentary overweight / obese workers (17 males and 6 females, mean ± SD: age 48.2 ± 7.9 years, body mass index 29,6 ± 4,0 kg · m (-2)	Plasma fasting glucose, triglycerides, and waist circumference were not significantly different between the two conditions when adjusted for time.

Legends: TG: triglycerides; MVPA: moderate to vigorous physical activity; WC: waist circumference; BMI: body mass index; CRP: C-reactive protein; FM: Fat mass; MetS: metabolic syndrome; ST: sedentary time; SBP: Systolic blood pressure; DBP: diastolic blood pressure.

IV. DISCUSSION

In this review, as shown in Table 2, most of the studies were interventional, and they evaluated changes in sedentary behavior to measure changes only in the components of the metabolic syndrome. Only 03 articles, transversal, all objectively measured, directly correlated metabolic syndrome with sedentary behavior.

These studies, which directly correlated metabolic syndrome with sedentary behavior, show a positive relationship between these variables, (SALEH; JANSSEN, 2014) showed this association even after controlling for confounding factors (odds ratio (OR) = 1.60) and (KING et al., 2016) also states that sedentary time was independently associated with a higher chance of metabolic syndrome (OR = 1.12). These data corroborate with that of other review studies, which also show this same increased chance (YOUNG et al., 2016).

One research found no association between increased sedentary time and chance of developing metabolic syndrome when controlled confounding factors

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(VAN DER VELDE et al, 2015). Thus, despite a tendency to an increased chance of developing metabolic syndrome when sedentary time is increased, data are insufficient to confirm this trend due to a lack of studies, as demonstrated in previous research (DE REZENDE, 2014; CHASTIN et al., 2015).

Regarding the components of the metabolic syndrome (glycemia, fasting HDL and triglycerides, blood pressure and waist circumference), it is also shown in the cross-sectional studies of this research, the chance of developing deleterious health outcomes when sedentary behavior is elevated. However, when researches that involved some intervention on the sedentary time-off are taken into account, only two studies showed a significant post-intervention difference (ZEIGLER et al., 2016; PUIG-RIBERA et al., 2015). These data are similar to those of the review by (DE REZENDE, 2014), where the authors state that there is insufficient evidence to confirm an association between individual cardiovascular risk factors and metabolic syndrome.

V. CONCLUSION

It is concluded, after analysis of the studies, that there is an association between high sedentary time and the development of metabolic syndrome, however, most intervention studies do not show a significant change in cardiometabolic components when sedentary time breaks with mild physical activity. Much of these non-significant results in the intervention studies cited in this review may be due to acute effect studies or rapid interventions.

For this reason, it is necessary that more longitudinal studies be developed to investigate the chronic effect of these interventions, the number of breaks in the sedentary time, and the necessary duration of the same, in order to have significant effects on the improvement of the cardiometábolic components

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